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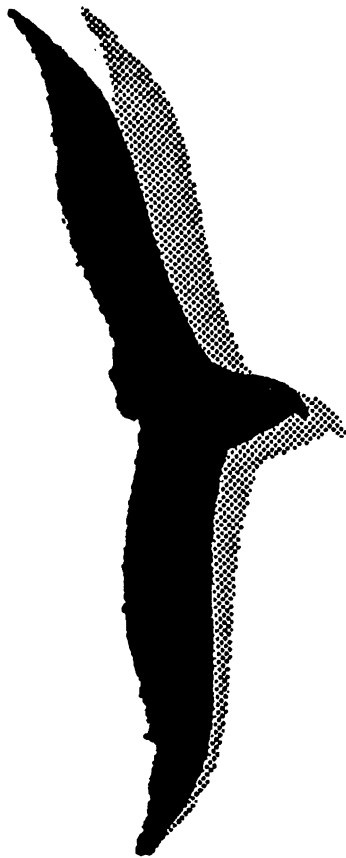
## Serie research memoranda

Labour flows as determinants of the wage-price spiral

Lourens Broersma  
Frank A.C. den Butter

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# **LABOUR FLOWS AS DETERMINANTS OF THE WAGE -PRICE SPIRAL**

An empirical analysis for The Netherlands

by

Lourens BROERSMA

and

Frank A.G. DEN BUTTER\*

## **ABSTRACT**

This study presents an empirical analysis of the influence of labour market flows on wage and price formation. A system of wage, price and employment equations in the vein of Nickell (1987) is estimated including labour flows as explanatory variables. A combination of the flow of layoffs (flow from employment to unemployment) and the flow of filled vacancies (successful matches) appears to be an adequate alternative to the unemployment rate as indicator of labour market tightness in the wage equation for The Netherlands.

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## 1. Introduction

The description of the wage formation process is crucial to models of the labour market. Traditionally, wage formation is explicitly modelled in a wage equation, which includes the influence of some measure of unemployment on wages. The first empirical studies on wage formation followed the work of Phillips (1958) and estimated specifications where wage increases were affected by the level of unemployment. More recently, the so-called wage curve specification has gained momentum, where the *change* in unemployment acts as explanatory variable for changes in wages. In both the wage curve and Phillips curve specification the unemployment rate or the change therein represents labour market pressure. See the model of Phelps (1968) for the theoretical foundation of the Phillips-curve and Sargan (1964), Blanchflower and Oswald (1990) and Graafland (1992) for the theory behind the wage curve. Nevertheless, these theories do not prescribe that the rate of unemployment is the sole indicator for labour market pressure. In earlier empirical studies on wage formation this indicator was merely used because of data availability. However, recently search theory and unemployment equilibrium theory (see e.g. Pissarides, 1990) demonstrated that it is important to take account of labour market flows in empirical studies of the labour market. In the context of a model with endogenous labour market flows, labour market pressure can very well be represented by the flow of layoffs in combination with the flow of filled vacancies. From that perspective, and now that time series data on these flows have become available for The Netherlands, our paper investigates whether data on labour flows constitute a feasible alternative for unemployment as measure of labour market pressure in the wage equation.

When labour market flows represent labour market tightness, it makes sense to start from a specification where the change in the wage rate is related to flows:  $\Delta w = f(F_i, F_o)$ , where  $w$  is the wage rate,  $F_i$  the inflow into unemployment and  $F_o$  the outflow from unemployment. This specification resembles a Phillips curve. However, when the flows have a similar but opposite effect, we get a relation between the change in the wage rate and the change in unemployment:  $\Delta w = f(\Delta U)$  where  $\Delta U \approx F_i - F_o$ . In other words, the specification where the change in wages depends on flows collapses into a wage curve when labour market flows represent labour market tightness with similar but opposite signs.

From the viewpoint of econometric estimation, we can argue that this wage setting process, be it via a Phillips curve or a wage curve, is part of a simultaneous system of equations describing the macroeconomic linkages between the labour and goods market. In order to deal with these problems of simultaneity we extend the approach of e.g. Nickell (1987) by specifying and estimating a system of wage, price and employment equations where employment changes are disaggregated to the component flows. The next section discusses the theoretical background of the model. Estimation results are presented in section 3. Finally section 4 concludes.

## 2. Labour market dynamics and wage formation

Here we follow the argument of Knoester and van der Windt (1987) that a Phillips curve specification can be derived from a wage bargaining process between wage earners and employers. Wage earners aim at maximisation of their real disposable income,

$$w_1(1 - t_1)/p_c = \xi_1 y,$$

where  $w_1$  is the wage rate claim of workers,  $t_1$  is the employee tax and social premium rate,  $p_c$  is the consumer price level,  $y$  is the production volume and  $\xi_1$  is a fraction of production, which may depend on the labour market pressure. Knoester and van der Windt provide arguments to sustain the premise that equation (1) is equivalent to

$$\Delta \log w_1 = \Delta \log p_c + \Delta \log (y/E) + (1-\gamma) \Delta \log \xi_1 + \gamma[\Delta \log (1-t_1) - \Delta \log p_c - \Delta \log y] \quad (1)$$

where  $E$  is the level of employment and hence  $\Delta \log (y/E)$  is the labour productivity growth and  $\gamma = (t_1/w_1)_{t-1}$ .

Wage offers by employers are derived from the marginal productivity conditions for profit maximising firms. The wage offer per worker is

$$\Delta \log w_2 = \Delta \log p_y + (1/\sigma) \Delta \log (y/E),$$

where  $w_2$  is the wage rate offer by employers,  $\sigma$  is the elasticity of substitution of the production function and  $p_y$  is the producer price level. Under the assumption that  $t_2$  is the employers tax and social premium rate, the wage offer can be rewritten in

$$\Delta \log w_2 = \Delta \log p_y + (1/\sigma) (1 + \eta(1 - a)) \Delta \log (y/E) - \eta(\Delta \log t_2 + \Delta \log p_y - \Delta \log y), \quad (2)$$

where  $\eta = (t_2/(w_2 - t_2))_{t-1}$ .

In order to arrive at a Phillips curve specification as outcome of the bargaining process, it is essential that the wage negotiations are about the wage changes and not about the wage level (which is actually the case as notified in press releases on wage negotiations in The Netherlands). The total wage rate change, as outcome of the bargaining process can be written as

$$\Delta \log w = (1 - \eta) ((1 - \lambda) \Delta \log w_1 + \lambda \Delta \log w_2) + \eta(\Delta \log t_2 - \Delta \log E), \quad (3)$$

where  $\lambda$  is the relative bargaining power of the employers. This bargaining power depends on the situation on the labour market, usually the level of unemployment.

Hence, unemployment as determinant of wage formation enters into this model through the assumption that bargaining power  $\lambda$  depends on the pressure the labour market situation exerts on wages. Traditionally it is assumed that the level of unemployment is a good indicator for this pressure. However, in the context of the flow approach to labour markets with endogenous labour market flows this labour market pressure can very well be represented by the flow of layoffs or the flow of filled vacancies or a combination of both.

The specification of the Phillips curve resulting from this bargaining theory asserts a stable relation between the change in the wage rate and other variables representing labour market dynamics. Based on the equations (1) through (3) and linearisation, we get

$$\Delta \log w = a_0 + a_1 \Delta \log p_c + \alpha_2 \Delta \log p_y + \alpha_3 \Delta \log h + \alpha_4 \Delta \log tp + a_5 X, \quad (4)$$

where  $h$  represents the labour productivity and  $tp$  are employers and employee taxes and social premiums. Furthermore,  $X$  represents variables of labour market pressure, be it either the (short-term) unemployment rate or appropriate measures of labour market flows.

The issue of identification has obtained ample attention in the theory of wage formation (see e.g. Manning, 1993). Therefore, as indicated above we estimate a system of wage, price and employment equations, where the set-up of Nickell (1987) yields the theoretical background for the specification and identification of the system. Our major amendment to Nickell's approach is that we have the flow of employed into unemployment,  $F_{eu}$ , and the flow of filled vacancies,  $F_{fv}$ , to determine the change in employment,  $\Delta E$ , as  $\Delta E \approx (F_{fv} - F_{eu})$ . Moreover, in accordance with the discussion in the introduction, the difference between  $F_{eu}$  and  $F_{fv}$  approximates the change in unemployment, as  $\Delta U \approx (F_{eu} - F_{fv})$ . We abstract from the flow of employed to non-participation, due to e.g. disability or retirement and assume that all vacancies are filled by unemployed. Needless to say that this is only a rough approximation of the true flows determining  $\Delta E$  and  $\Delta U$ . However, the flows between  $F_{eu}$  and  $F_{fv}$  are the only flows available on a quarterly basis, on which we conduct our empirical analysis.

With respect to wage setting in this approach the theory, and hence the resulting wage equation, almost concords with the outcome of the generalised Nash bargaining solution presented above. We note that the labour market flows as indicators of internal labour market pressure represent bargaining power,  $\lambda$ .

Besides the wage rate, the simultaneous model of our paper also describes the price level. The price level is determined in a simple demand-supply model. Supply, or production, is specified as a simple production function, depending solely on the production factor labour

$$y = \phi E^\lambda,$$

where  $\phi$  and  $\lambda$  are positive parameters. Demand for goods is given by

$$y = (w/p_c)^\gamma I_d,$$

where  $(w/p_c)$  is the real consumption wage rate,  $I_d$  is an index of demand and  $\gamma$  is a positive parameter. Cf. Layard, Nickell and Jackman (1991). Equilibrium on the goods market implies that

$$\phi E^\theta = (w/p_c)^\gamma I_d.$$

In log-linear terms this can be rewritten into

$$\log p_c = \xi + \log w - (\theta/\gamma)\log E,$$

where  $\xi = (1/\gamma)\{\log I_d - \log \phi\}$  is assumed to be constant. This model implies that a wage increase leads to an equal increase in the price level. If we assume that wage setting is linear homogeneous with respect to the price level, it represents the wage-price spiral.

If we consider price inflation, the price equation can readily be rewritten in

$$\Delta \log p_c = \Delta \log w - (\theta/\gamma)\Delta \log E, \tag{5}$$

where the percentage change in employment  $\Delta \log E$  has a similar pattern as  $\Delta E$ . We saw earlier that  $\Delta E$  can be approximated by  $F_{fv} - F_{cu}$ .

The last equations of this system in the vein of Nickell (1987) refer to employment setting. When we start from the assumption that 'the firm's objective is profit maximisation, it is relatively easy to determine the level of employment. When profit is simply

$$\pi = py - wE,$$

we can derive that employment  $E$  is determined by

$$\log E = \xi + 1/(\theta-1) \log (w/p),$$

where  $\xi = (1/(\theta-1) * \log (1/ \phi\theta))$  and the price level  $p$  can be either the consumption or production price level. This depends on the type of firm under consideration. Hence we find that employment depends on the real wage level, or the change in employment depends on the change in the real wages. Since, as before, the change in employment  $\Delta E$  can be represented by the difference between  $F_{fv}$  and  $F_{eu}$ , this implies that both  $F_{fv}$  and  $F_{eu}$  are a function of the change in the real wage rate.

Another way to specify models of employment flows is by their influence on the costs that firms have to make to adjust their level of employment. Cf. Hamermesh and Pfann (1996), Hassink and Broersma (1996) and Broersma and Hassink (1997). The latter study derives models for the flow of new hires and the flow of workers into unemployment, based on optimising framework having the following features. Firms maximise their expected discounted profits towards employment. Their production process is described by a concave second-order polynomial in the production factors. Hiring and layoff costs are described by a convex quadratic function in the number of hires or layoffs. Like all studies of labour demand, we assume that quits are exogenous and costless to firms. Assuming there are two types of firms: either always hiring or continuously laying off. In that case the hiring and firing decision of hypothetical, non-firing firms or non-hiring firms, respectively, are based on (see Hassink, 1996, Chapter 7)

$$f_{fv} = \lambda_1 f_{fv,-1} + \eta_{13} Q + \eta_{14} Z$$

and

$$f_{eu} = \lambda_2 f_{eu,-1} + \eta_{23} Q + \eta_{24} Z,$$

where  $f_{fv}$  is the ratio of the flow of filled vacancies and the labour force,  $F_{fv}/(E+U)$ , and  $f_{eu}$  is the ratio of the flow of layoffs and the labour force,  $F_{eu}/(E+U)$ . Furthermore,  $\lambda$  and  $\eta$  are parameters,  $Q$  represents the quits and  $Z$  is the vector of driving variables. Obviously the change in the real wage level is the most important variable in  $Z$ .

Cross-terms in the lagged  $f_{fv}$  and  $f_{eu}$  can be incorporated by the assumption that unobservable heterogeneous groups of workers are aggregated towards the firm level. While hiring workers of some specific type of labour, firms may lay off other types of labour. The previous equations for  $f_{fv}$  and  $f_{eu}$  are encompassed by

$$f_{fv} = \eta_{11} f_{fv,-1} + \eta_{12} f_{eu,-1} + \eta_{13} Q + \eta_{14} Z, \quad (6)$$



$$f_{eu} = \eta_{21}f_{iv,-1} + \eta_{22}f_{eu,-1} + \eta_{23}Q + \eta_{24}Z. \quad (7)$$

### 3. Estimation results

Equations (4) through (7) provide a simple model, which represents wage setting, price inflation and the flows into and out of employment. We have estimated this system of equations using seasonally adjusted quarterly data from 1969:I-1997:IV. We started with a large model specification, including lags to avoid residual correlation. The specification according to (4)-(7) does not give rise to presence of a unit root. Table 1 shows the Dickey-Fuller test results for the variables involved. Only for  $f_{eu}$  a unit root could not be denied. Hence, in this equation we have used  $\Delta f_{eu}$  instead of  $f_{eu}$ .

The equations that eventually emerge after simplification of the initial model are presented in Table 2. Because of the strong interrelationships between wages, prices and employment (*i. e.* in this paper  $f_{iv}$  and  $f_{eu}$ ), they will be estimated with the seemingly unrelated regression estimation (SURE) method. As driving variables  $Z$  in the two employment flows is represented by the change of the real wage rate. The quit rate is not available for The Netherlands as a quarterly series, so we approximated the quits by the quarterly unemployment-vacancy ratio. Cf. Burgess (1988). We found no significant and plausible effect of the unemployment-vacancy ratio on the flow variables. The change in the real wage rate, where wages are deflated with the producers price index, does affect both the flow of layoffs and the flow of filled vacancies. An increase in real wages cause a rise in layoffs and a fall in filled vacancies.

The equations of Table 2 are tested on absence of residual autocorrelation, homoscedasticity and normally distributed errors. Due to a number of breaks, especially in  $f_{eu}$  normality and homoscedasticity is not always fulfilled. See the data appendix for more details. Nevertheless, absence of autocorrelated disturbances is a much more important criterion, which is fulfilled in all cases.

These estimation results have the two major implications. First, the difference between the two flows has a significant impact on the wage equation. There is however only a weakly significant relation between the labour market flows and the price equation. In any case, the relation implied by the theory behind this model is not rejected. Labour market flows may serve equally well in a wage equation to represent labour market tightness, both from a theoretical as from an empirical point of view.

The second implication of the estimates of the simultaneous model of this section is that the

combination of the four equations, including the equations for the flow of new hires and the flow of layoffs, provides the mechanism to restore equilibrium in case of a shock. A rise in the flow of layoffs lowers wages and raises prices, which in its turn lowers layoffs and raises filled vacancies. In its turn a rise in the flow of filled vacancies also lowers the flow of layoffs. The opposite occurs when the flow of filled vacancies rises.

Figures 1 and 2 show the impulse response of a permanent 20%-point increase in the flow of layoffs to the change in the real wage rate and the change in unemployment over 80 periods (1978:I-1997:IV). The size of the shock corresponds to 1 standard deviation of this flow.

Figure 1 shows that the rise in layoffs leads in the first years after the shock to a fall in the real wage. The trough is reached after four years where it is about 0.5 % lower than in the baseline projection. After four years the real wage rate gradually moves to a new equilibrium. Hence, the change of the real wage rate moves back to its equilibrium value of zero. Figure 2 gives an impression of the change in unemployment due to the 20%-point impulse in the flow of layoffs. We have approximated the change in unemployment by the difference between the flow of layoffs and the flow of filled vacancies, or  $\Delta U \approx (F_{\text{eu}} - F_{\text{fv}})$ , relative to the baseline projection. Figure 2 is also quite revealing. Unemployment increases due to the shock to reach a peak of 0.5 % above the level of the baseline after two years. Thereafter, the change in unemployment rapidly moves back to its equilibrium value of zero. Despite the fact that the flow of layoffs is permanently higher than in the baseline projection, the shock has much smaller effect on the change in unemployment than one might expect. In the end the shock has died out. The Dutch labour market is known to adjust relatively quick to adverse shocks. This is partly due to the restructuring of the Dutch welfare state institutions starting in the second half of the 1980's. Cf. Broersma, Koeman and Teulings (1999). Yet, although the Dutch economy appears to be relatively flexible and returns to its original equilibrium in the end, our modelling exercise shows that the dynamics of the propagation of a shock cause the economy to be off equilibrium for quite a long time.

(figures 1 and 2 about here)

## 5. Concluding remarks

This paper estimates a four equation simultaneous model for wage formation in The Netherlands where time series data on labour market flows which have recently become available are used as indicators of labour market pressure and bargaining power in the wage negotiation process. The model is an extension of the wage-price spiral model by Nickell (1987). Its empirical results show that labour flows are a good alternative to the unemployment rate which is traditionally taken as indicator of labour market pressure in Phillips curve and wage curve specifications of

the wage equation. From an impulse-response analysis using the model it appears that a permanent increase in the number of layoffs leads to a temporary increase of the unemployment rate and to a relative decrease of the wage rate. In this respect the simulation shows that such structural change in labour market dynamics can be at the origin of a short run Phillips curve relationship. However, on the long run, the labour market seems to return to its original equilibrium.

**Table 1.**            **Unit root test results**

Variable	Dickey-Fuller unit root test statistic	degrees of freedom
$\Delta \log w$	-1.291	4
$\Delta \log p_y$	-2.436	4
$\Delta \log p_c$	-1.204	4
$\Delta \log h^1$	-5.992*	4
$f_{cu}$	-2.045*	4
$f_{iv}$	-3.807	4

\* the presence of a unit root at 5% significance cannot be denied

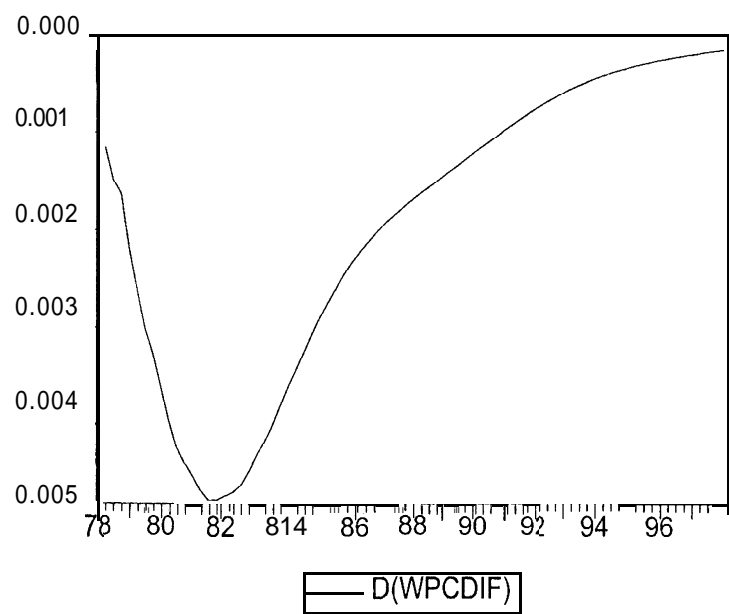
<sup>1</sup> the unit root in  $\Delta \log h$  is due to a break around 1975:I. Correction implies stationarity. Cf. Perron (1989).

**Table 2.** Estimation results of system of wage-price spiral and flow equations, 1969:I-1997:IV for The Netherlands.

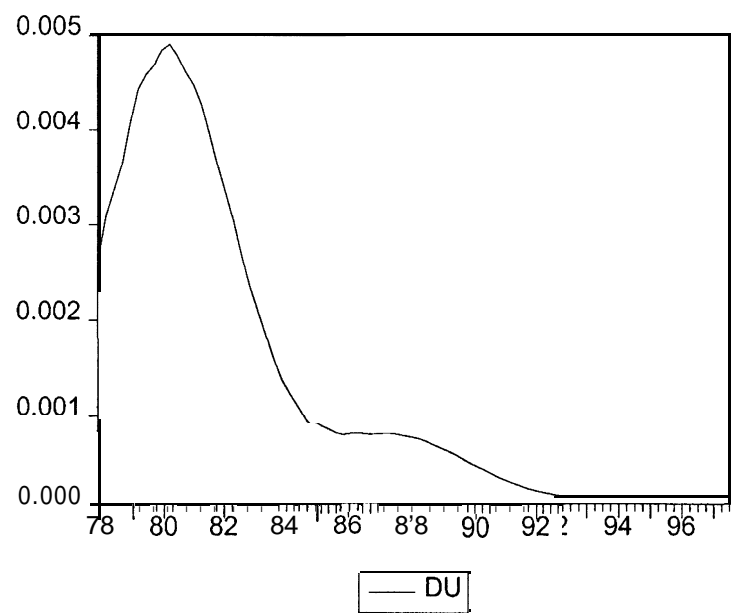
wage	setting	$\Delta \log w = \mu_1 + \alpha_1 \Delta(\log w_{-2} + \log w_{-4} + \log w_{-5}) + \alpha_2 \Delta \log p_{y,-2} + \alpha_3 \Delta \log f_{iv,-1} + \beta(f_{cu} - f_{iv})_{-1}$			
price	setting	$\Delta \log p_c = \mu_2 + \Delta \log w + \gamma \Delta(\log p_{c,-4} - \log w_{-4}) + \delta(f_{iv} - f_{cu})_{-1}$			
flow of filled vacancies		$\Delta f_{cu} = \mu_3 + \phi_1 \Delta f_{cu,-1} + \phi_2 \Delta f_{cu,-2} + \phi_3 f_{iv,-1} + \phi_4 \Delta(\log w_{-5} - \log p_{y,-5})$			
flow of layoffs		$f_{iv} = \mu_4 + \iota_1 f_{iv,-1} + \iota_2 f_{iv,-2} + \iota_3 f_{iv,-3} + \iota_4 f_{v,-4} + \iota_5 f_{iv,-5} + \iota_6 f_{cu,-1} + \iota_7 \Delta(\log w_{-5} - \log p_{y,-5})$			
<hr/>					
<u>wage setting:</u>		<u>price setting:</u>			
$\mu_1$	0.001 (0.684)	$\mu_2$	-0.000 (-0.369)		
$\alpha_1$	0.236 (13.23)	$\gamma$	0.241 (3.483)		
$\alpha_2$	0.114 (2.608)	$\delta$	-0.161 (-1.970)		
$\alpha_3$	0.266 (2.121)				
	-0.135 (-2.214)				
<hr/>					
$R^2$	0.700	$R^2$	0.124		
$\sigma$	0.007	$\sigma$	0.009		
T	109	T	109		
AR	F(1,101)=0.781 F(5,97)=0.391	AR	F(1,105)=0.758 F(5,101)=1.555		
ARCH	F(1,108)=0.229 F(5,104)=0.283	ARCH	F(1,108)=2.232 F(5,104)=2.088		
N	$\chi^2(2)=7.023^*$	N	$\chi^2(2)=36.67^*$		
<hr/>					
<u>flow of layoffs:</u>		<u>flow of filled vacancies:</u>			
$\mu_3$	-0.000 (-1.505)	$\mu_4$	0.007 (3.932)		
$\phi_1$	0.236 (2.654)	$\iota_1$	1.083 (12.92)		
$\phi_2$	0.385 (4.368)	$\iota_2$	-0.475 (-3.642)		
$\phi_3$	0.011 (1.504)	$\iota_3$	0.439 (3.283)		
$\phi_4$	0.006 (1.462)	$\iota_4$	0.251 (1.927)		
		$\iota_4$	-0.458 (-5.666)		
		$\iota_4$	-0.177 (-2.404)		
		$\iota_4$	-0.037 (-1.948)		
<hr/>					
$R^2$	0.370	$R^2$	0.902		
$\sigma$	7E-04	$\sigma$	0.003		
T	106	T	105		
AR	F(1,101)=1.806 F(5,97)=2.589	AR	F(1,99)=0.408 F(5,95)=0.737		
ARCH	F(1,105)=1.345 F(5,101)=4.566*	ARCH	F(1,104)=0.846 F(5,100)=1.264		
N	$\chi^2(2)=68.17^*$	N	$\chi^2(2)=0.220$		

Explanatory note: t-values between parentheses, values of test statistics marked \* imply that the corresponding null hypothesis is not rejected at 5% significance.

**Figure 1.** Impulse response of change in the real wage to a 20%-point permanent increase in the flow of layoffs



**Figure 2.** Impulse response of the change in unemployment to a 20%-point permanent increase in the flow of layoffs



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## DATA APPENDIX: DEFINITIONS AND SOURCES

The quarterly data of this study were mainly taken from the OECD, *Main Economic Indicators (MEI)*. Yearly data, which were interpolated to yield quarterly series, were mainly obtained from the Netherlands Central Planning Bureau (CPB), *Lange reeksen (LR)*. Interpolation was done by means of a third order polynomial function, see also Hassink and Broersma (1996). The Netherlands Central Bureau of Statistics is abbreviated as CBS.

- w:** index of hourly wage rates in manufacturing  
source: OECD, *MEI*.
- $p_c$ :** price index of total consumption  
source: OECD, *MEI*.
- $p_y$ :** price index of total production  
source: OECD, *MEI*.
- h:** measure of labour productivity in the market sector. Interpolated.  
source: CPB, *LR*.
- rr:** replacement ratio, defined as the average benefit level with respect to the minimum wage  
source: CPB, *LR*.
- tp:** taxes and social premiums of employers and employees taken together, as percentage of the gross wage costs of the market sector.  
source: CPB, *LR*.
- $f_{eu}$ :** flow of employed persons into unemployment, as percentage of the labour force. 1969.I-J 1989.IV is interpolated. This interpolation causes a break between 1989 and 1990. Dummy variables could not adequately correct for this.  
source: Sociale Verzekeringraad, *Kroniek van de sociale verzekeringen*.
- $f_v$ :** flow of filled vacancies, as percentage of the labour force. We have used yearly data on vacancy flows of the Public Employment Office of the period 1970-1978 from Hartog (1980) to calculate average vacancy durations. For 1980-1987, we have used CBS vacancy survey data and applied the method described in Van Ours and Ridder (1991). Quarterly data for 1969:I- 1988 .III were obtained through interpolation. For 1988:IV-1997:IV, we use data from the CBS, *Sociaal econo-*

*mische maandstatistiek.*